

WHAT IS CLAIMED IS:

1. A method of manufacturing a semiconductor device, comprising:

a first step of introducing, into an amorphous semiconductor film, a metallic element for promoting crystallization of the amorphous semiconductor film;

a second step of forming a first crystalline semiconductor film in which the amorphous semiconductor film is partially crystallized in accordance with heat treatment; and

a third step of irradiating a laser beam on the first crystalline semiconductor film, to form a second crystalline semiconductor film;

wherein a region of the first crystalline semiconductor film which becomes an active layer of a TFT is crystallized in an amount from 92 to 99%.

2. A method according to claim 1, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

3. A method according to claim 1, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

4. A method according to claim 1, wherein the semiconductor

device is a liquid crystal display device or an image sensor.

5. A method according to claim 1, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

6. A method of manufacturing a semiconductor device, comprising:

a first step of introducing, into an amorphous semiconductor film, a metallic element for promoting crystallization of the amorphous semiconductor film;

a second step of forming a first crystalline semiconductor film in which the amorphous semiconductor film is partially crystallized in accordance with heat treatment; and

a third step of irradiating a laser beam on the first crystalline semiconductor film, to form a second crystalline semiconductor film;

wherein:

the first crystalline semiconductor film formed in accordance with the second step is crystallized in an amount from 92 to 99% in a region which becomes an active layer of a TFT; and

the second crystalline semiconductor film formed in accordance with the third step is crystallized in an amount equal to or greater than 99% in the region which becomes the active layer of the TFT.

7. A method according to claim 6, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

8. A method according to claim 6, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

9. A method according to claim 6, wherein the semiconductor device is a liquid crystal display device or an image sensor.

10. A method according to claim 6, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

11. A method of manufacturing a semiconductor device, comprising:

a first step of introducing, into an amorphous semiconductor film, a metallic element for promoting crystallization of the amorphous semiconductor film;

a second step of forming a first crystalline semiconductor film in which the amorphous semiconductor film is partially

crystallized in accordance with heat treatment; and

a third step of irradiating a laser beam on the first crystalline semiconductor film, to form a second crystalline semiconductor film;

wherein a region of the first crystalline semiconductor film which becomes an active layer of a TFT is crystallized in an amount from 94 to 99%.

12. A method according to claim 11, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

13. A method according to claim 11, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

14. A method according to claim 11, wherein the semiconductor device is a liquid crystal display device or an image sensor.

15. A method according to claim 11, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

16. A method of manufacturing a semiconductor device,

comprising:

a first step of introducing, into an amorphous semiconductor film, a metallic element for promoting crystallization of the amorphous semiconductor film;

a second step of forming a first crystalline semiconductor film in which the amorphous semiconductor film is partially crystallized in accordance with heat treatment; and

a third step of irradiating a laser beam on the first crystalline semiconductor film, to form a second crystalline semiconductor film;

wherein:

the first crystalline semiconductor film formed in accordance with the second step is crystallized in an amount from 94 to 99% in a region which becomes an active layer of a TFT; and

the second crystalline semiconductor film formed in accordance with the third step is crystallized in an amount equal to or greater than 99% in the region which becomes the active layer of the TFT.

17. A method according to claim 16, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

18. A method according to claim 16, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

19. A method according to claim 16, wherein the semiconductor device is a liquid crystal display device or an image sensor.

20. A method according to claim 16, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

21. A method of manufacturing a semiconductor device, comprising:

a first step of introducing, into an amorphous semiconductor film, a metallic element for promoting crystallization of the amorphous semiconductor film;

a second step of forming a first crystalline semiconductor film in which the amorphous semiconductor film is partially crystallized in accordance with heat treatment; and

a third step of irradiating a laser beam on the first crystalline semiconductor film, to form a second crystalline semiconductor film;

wherein the total surface area of an amorphous region, in a region of the first crystalline semiconductor film which becomes an active layer of a TFT, is set from 1 to 8% of the surface area of the region which becomes the active layer of the TFT.

22. A method according to claim 21, wherein the metallic element is an element, or a plurality of elements, chosen from the group

consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

23. A method according to claim 21, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

24. A method according to claim 21, wherein the semiconductor device is a liquid crystal display device or an image sensor.

25. A method according to claim 21, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

26. A method of manufacturing a semiconductor device, comprising:

a first step of introducing, into an amorphous semiconductor film, a metallic element for promoting crystallization of the amorphous semiconductor film;

a second step of forming a first crystalline semiconductor film in which the amorphous semiconductor film is partially crystallized in accordance with heat treatment; and

a third step of irradiating a laser beam on the first crystalline semiconductor film, to form a second crystalline semiconductor film;

wherein:

the first crystalline semiconductor film formed in accordance with the second step has the total surface area of an amorphous region, in a region which becomes an active layer of a TFT, set from 1 to 8% of the surface area of the region which becomes the active layer of the TFT; and

the second crystalline semiconductor film formed in accordance with the third step has the total surface area of the amorphous region, in the region which becomes the active layer of the TFT, set equal to or less than 1% of the surface area of the region which becomes the active layer of the TFT.

27. A method according to claim 26, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

28. A method according to claim 26, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

29. A method according to claim 26, wherein the semiconductor device is a liquid crystal display device or an image sensor.

30. A method according to claim 26, wherein the semiconductor

device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

31. A method of manufacturing a semiconductor device, comprising:

a first step of introducing, into an amorphous semiconductor film, a metallic element for promoting crystallization of the amorphous semiconductor film;

a second step of forming a first crystalline semiconductor film in which the amorphous semiconductor film is partially crystallized in accordance with heat treatment; and

a third step of irradiating a laser beam on the first crystalline semiconductor film, to form a second crystalline semiconductor film;

wherein the total surface area of an amorphous region, in a region of the first crystalline semiconductor film which becomes an active layer of a TFT, is set from 1 to 6% of the surface area of the region which becomes the active layer of the TFT.

32. A method according to claim 31, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

33. A method according to claim 31, wherein the metallic element is one element, or a plurality of elements, chosen from the group

consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

34. A method according to claim 31, wherein the semiconductor device is a liquid crystal display device or an image sensor.

35. A method according to claim 31, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

36. A method of manufacturing a semiconductor device, comprising:

a first step of introducing, into an amorphous semiconductor film, a metallic element for promoting crystallization of the amorphous semiconductor film;

a second step of forming a first crystalline semiconductor film in which the amorphous semiconductor film is partially crystallized in accordance with heat treatment; and

a third step of irradiating a laser beam on the first crystalline semiconductor film, to form a second crystalline semiconductor film;

wherein:

the first crystalline semiconductor film formed in accordance with the second step has the total surface area of an amorphous region, in a region which becomes an active layer of a TFT, set from 1 to 6% of the surface area of the region which becomes the

active layer of the TFT; and

the second crystalline semiconductor film formed in accordance with the third step has the total surface area of the amorphous region, in the region which becomes the active layer of the TFT, set equal to or less than 1% of the surface area of the region which becomes the active layer of the TFT.

37. A method according to claim 36, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

38. A method according to claim 36, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

39. A method according to claim 36, wherein the semiconductor device is a liquid crystal display device or an image sensor.

40. A method according to claim 36, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

41. A method of manufacturing a semiconductor device,

comprising:

a first step of introducing, into an amorphous semiconductor film, a metallic element for promoting crystallization of the amorphous semiconductor film;

a second step of partially crystallizing the amorphous semiconductor film in accordance with heat treatment, to form a first crystalline semiconductor film possessing a plurality of amorphous regions; and

a third step of irradiating a laser beam on the first crystalline semiconductor film, to form a second crystalline semiconductor film;

wherein:

the surface area of each of the plurality of amorphous regions in a region of the first crystalline semiconductor film which becomes an active layer of a TFT is equal to or less than $10\ \mu\text{m}^2$, and among the plurality of amorphous regions, at least one amorphous region has a surface area equal to or greater than $0.3\ \mu\text{m}^2$.

42. A method according to claim 41, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

43. A method according to claim 41, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

44. A method according to claim 41, wherein the semiconductor device is a liquid crystal display device or an image sensor.

45. A method according to claim 41, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

46. A semiconductor device comprising an active layer of a TFT, wherein:

a metallic element for promoting crystallization of an amorphous semiconductor film is introduced to the amorphous semiconductor film;

a region of the amorphous semiconductor film which becomes an active layer of a TFT is crystallized from 92 to 99% in accordance with heat treatment, to form a first crystalline semiconductor film; and

a laser beam is irradiated on the first crystalline semiconductor film, to form a second crystalline semiconductor film taken as the active layer of the TFT.

47. A device according to claim 46, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

48. A device according to claim 46, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

49. A device according to claim 46, wherein the semiconductor device is a liquid crystal display device or an image sensor.

50. A device according to claim 46, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

51. A semiconductor device comprising an active layer of a TFT, wherein:

a metallic element for promoting crystallization of the amorphous semiconductor film is introduced to the amorphous semiconductor film;

a region of the amorphous semiconductor film which becomes an active layer of a TFT is crystallized from 94 to 99% in accordance with heat treatment, to form a first crystalline semiconductor film; and

a laser beam is irradiated on the first crystalline semiconductor film, to form a second crystalline semiconductor film taken as the active layer of the TFT.

52. A device according to claim 51, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pd, P, As, and Sb.

53. A device according to claim 51, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

54. A device according to claim 51, wherein the semiconductor device is a liquid crystal display device or an image sensor.

55. A device according to claim 56, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

56. A semiconductor device comprising an active layer of a TFT, wherein:

a metallic element for promoting crystallization of an amorphous semiconductor film is introduced to the amorphous semiconductor film;

the amorphous semiconductor film is crystallized in accordance with heat treatment to form a first crystalline

semiconductor film;

the total surface area of an amorphous region in a region of the first crystalline semiconductor film which becomes an active layer of a TFT is from 1 to 6% of the surface area of the region which becomes the active layer of the TFT; and

a laser beam is irradiated on the first crystalline semiconductor film, to form a second crystalline semiconductor film taken as the active layer of the TFT.

57. A device according to claim 56, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

58. A device according to claim 56, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

59. A device according to claim 56, wherein the semiconductor device is a liquid crystal display device or an image sensor.

60. A device according to claim 56, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.

61. A semiconductor device comprising an active layer of a TFT, wherein:

a metallic element for promoting crystallization of an amorphous semiconductor film is introduced to the amorphous semiconductor film;

the amorphous semiconductor film is crystallized in accordance with heat treatment to form a first crystalline semiconductor film;

the surface area of each amorphous region in a region of the first crystalline semiconductor film which becomes an active layer of a TFT is equal to or less than $10\ \mu\text{m}^2$, and at least one of the amorphous regions has a surface area equal to or greater than $0.3\ \mu\text{m}^2$; and

a laser beam is irradiated on the first crystalline semiconductor film, to form a second crystalline semiconductor film taken as the active layer of the TFT.

62. A device according to claim 61, wherein the metallic element is an element, or a plurality of elements, chosen from the group consisting of Ni, Pd, Pt, Cu, Ag, Au, Al, In, Sn, Pb, P, As, and Sb.

63. A device according to claim 61, wherein the metallic element is one element, or a plurality of elements, chosen from the group consisting of periodic table group 8 elements, group 1B elements, group 3B elements, group 4B elements, and group 5B elements.

64. A device according to claim 61, wherein the semiconductor device is a liquid crystal display device or an image sensor.

65. A device according to claim 61, wherein the semiconductor device is a portable telephone, a video camera, a digital camera, a projector, a goggle type display, a personal computer, a DVD player, an electronic book, or a portable information terminal.